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UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE H.H. BENNETT-CHIEF

WESTERN GULF REGION
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REPORT ON SEDIMENTATION IN LAKE HALBERT RESERVOIR SYSTEM

CORSICANA, TEXAS

BY
VICTOR H. JONES and JAMES A. OGLE

Fort Worth, Texas
May 1950
SCS-TP-92

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Introduction

Special Aspects of the Lake Halbert System

Lake Halbert serves the City of Corsicana as a municipal water supply and is used for recreation including fishing and picnicking. Some water is piped to an oil company for pumping plant operations, and during the war water was pumped to a nearby Army Aviation training field. In April 1950 the total population of Corsicana, as estimated by utilities officials, was 22,500, and the average daily per capita water consumption was 80 gallons. Total daily draft is somewhat in excess of 1,600,000 gallons per day. The Lake Halbert system, including Magnolia Lake, Beaton Lakes, and other sediment catchment basins, is a good example of the utilization of sediment traps. The relationships between dams, drainage areas, and contribution of sediment from the various tributary and subtributary areas are complex, but they are presented as accurately as present data permit in later sections of this report. The drainage area as a whole is typical of a large part of the Black Prairie belt in the Trinity River Basin.

Authority for the Investigation

Following a request by the City of Corsicana, a cooperative detailed survey of sedimentation in Lake Halbert and subsidiary basins was arranged in August 1949 by the Fort Worth office of the Soil Conservation Service and the City. Increasing water consumption and reduction of storage capacity in the reservoir by sedimentation had caused much concern as to the adequacy of the municipal water supply. During the dry summer of 1949 the water level of Lake Halbert stood near record low levels of 6 feet and more below spillway for some weeks, and large sediment deposits were exposed.

Accurate information on rates of sediment output in Blackland drainage areas is needed by the Soil Conservation Service in developing the Department of Agriculture Flood Control Operations Program, which was initiated in the Trinity River Basin in 1946. The Lake Halbert sedimentation data are appropriate for planning new reservoirs for flood control in similar upland drainage areas. (See Location Map, Fig.1)

Previous Studies of Lake Halbert

Some information on sedimentation in Lake Halbert and subsidiary basins had been previously assembled, but no accurate detailed surveys had been made prior to 1949. The first investigation of sedimentation in Lake Halbert was a reconnaissance survey by E. M. Flaxman of the Soil Conservation Service in April 1939. A summary of the results together with similar data on 30 other reservoirs, was published in the Flood Control Survey Report on the Trinity River Basin by the Department of Agriculture.[1] Sedimentation data from the Flood Control Survey were used by the late A. N. Garin as a basis for an economic study of the effects of sedimentation on municipal water supplies in the Trinity River Basin.[2] An economic evaluation of Lake Halbert was included. In 1942-43 additional studies of reservoir sedimentation in the area, including an evaluation of the desilting structures around Lake Halbert, were made for a comprehensive report on the problem by Victor H. Jones.[3] A description of the desilting basin systems also is included in a report by Carl B. Brown.[4]

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[1] Survey Report on the Trinity River Watershed, Texas, U.S. Dept. of Agriculture, House Doc. 708, 77th Congress, 2nd Session, 1942.

[2] Garin, A. N. and Gabbard, L. P., Land Use in Relation to Sedimentation in Reservoirs, Trinity River Basin, Texas, Tex. Agric. Exper. Sta. Bull. 597, Jan. 1941.

[3] Jones, Victor H., Reservoir Sedimentation and Drainage Area Influences in the Trinity River Basin, Texas (unpublished report), Soil Cons. Serv.

[4] Brown, Carl B., The Control of Reservoir Silting, Misc. Publ. No. 521, USDA, 1944, pp. 36-37.

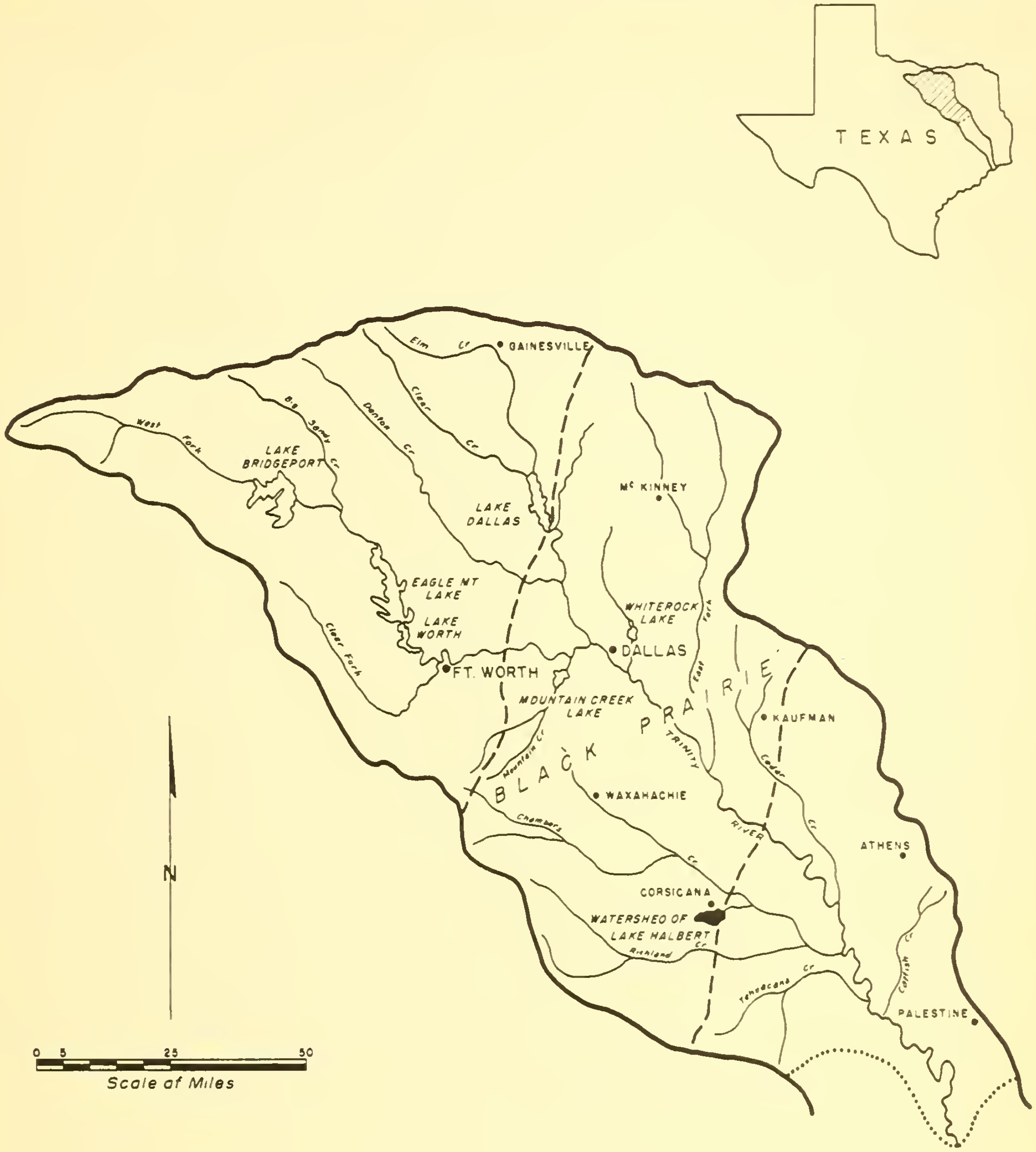

Figure 1

UPPER TRINITY RIVER BASIN
AND LAKE HALBERT WATERSHED
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Purposes of the Investigation

The chief objectives of the Lake Halbert survey were as follows:

1. To determine the original and present capacities of Lake Halbert, to calculate the rate of capacity loss by sedimentation, and to prepare an accurate shore-line map of the lake.
2. To evaluate the effectiveness of the sediment traps and auxiliary basins in reducing sedimentation in the main reservoir.
3. To obtain data on rates of sediment contribution in the drainage area and to compare present rates and land conditions with those of the period prior to 1940.

Acknowledgments

The active cooperation of the City of Corsicana, through its officials and employees, was an important factor in the Lake Halbert Survey. Hubert F. Braselton, Mayor, and Fred Blucher, City Engineer, arranged for City employees to assist the survey party as necessary, and supplied boats and motors and material for survey markers and monuments. Kenneth May, Superintendent of the Lake, assisted with the survey and furnished information on lake levels and water use.

Description of the Reservoir and Auxiliary Basins

Lake Halbert

Lake Halbert dam is located on Elm Creek 4.5 miles southeast from the Corsicana City Hall in Navarro County, Texas (See Location Map, Fig. 1). Elm Creek joins Chambers Creek, a major western tributary of the Trinity River, about 6 miles southeasterly from the dam. The lake was constructed in 1921 at a cost of $421,000. In 1935-36 the dam was raised, the 8 desilting basins were built, and a road around the lake was constructed, all at an additional cost of $95,872. The total expenditures for the entire development, including filter plant and pipeline were $517,000.

The dam is of earth-fill construction, and has a total length of 2780 feet extending across Elm Creek valley in a direction somewhat north of west. The top of the dam has an elevation of 375.9 feet above sea level and a maximum height of 49 feet above the channel bottom. The thickness of the embankment is 18 feet at the crest and 250 feet at the base. Slopes are 3:1 upstream and 2:1 downstream. The concrete spillway, located at the west end of the dam, has an effective width of 520 feet and a discharge capacity of 13,500 c.f.s. with a 5-foot depth of flow. The elevation of the spillway crest is 367.0 feet above sea level. A 24-inch outlet pipe at the channel admits water to the City system. In January 1950, since this survey was completed, the spillway crest was raised 1 foot to an elevation of 368 feet.

The reservoir basin has a maximum length of 11,700 feet and an average width of 1239 feet. Its maximum original depth was 40 feet, and the average original depth was 11.8 feet. The original capacity, excluding auxiliary sediment impounding basins, was 8055 acre-feet and the surface area was 593 acres as determined by this survey. The western shores have relatively low slopes of 2 to 4 percent, but the eastern slopes rise more steeply to a height of nearly 100 feet above the lake within one-fourth mile. This slope has a number of conspicuous gullies.

Smaller Auxiliary Basins

Five small dams are located on the east shore of Lake Halbert at entrances of gully channels to the main lake (see Reservoir Map, Fig.2, and Table 3). Their combined original capacity was approximately 7.57 acre-feet, and all of them were constructed in 1936 for partial sediment control.

Larger Basins Contiguous with Lake Halbert

Rock Dam No. 1 on Elm Creek at the head of Lake Halbert was built in 1936, and its basin had an original capacity of 9.7 acre-feet. By September 1949 it had impounded 6.9 acre-feet of sediment, although water and sediment bypass this dam during periods of storm runoff. Its desilting effect, therefore, now is negligible (see Drainage Area Map, Fig. 5).

Earth Dam No. 1 at the head of the southwest arm also was built in 1936. It impounds water from the stream on which the Beaton Lakes are located and had an original capacity of 26.24 acre-feet. Its capacity has been mostly depleted by sedimentation.

Burke Neck, also called Earth Dam No. II, extends across the northwestern arm of Lake Halbert about 0.4 mile below its head. It was constructed in 1880 for the first municipal water supply of Corsicana. Its original area was 29 acres and its original capacity was 181 acre-feet. It has no connection with the main lake below spillway level and its water usually stands at a higher stage than that of Lake Halbert. Water from Magnolia Lake on rare occasions flows through an excavated channel into Burke Neck, but only when the water level in Magnolia Lake is at high stages (see Maps Figs 3 and 5).

Auxiliary Lakes Upstream from Lake Halbert

Magnolia Lake, also called Red Horse Lake, is impounded by an earth-fill dam on a tributary stream 0.7 mile west from the Lake Halbert Dam. The excavated channel from Magnolia Lake to Burke Neck is its only spillway. Two 6-inch siphons at the Magnolia Dam are used to draw the lake level to about 2 feet below spillway when the lake fills with

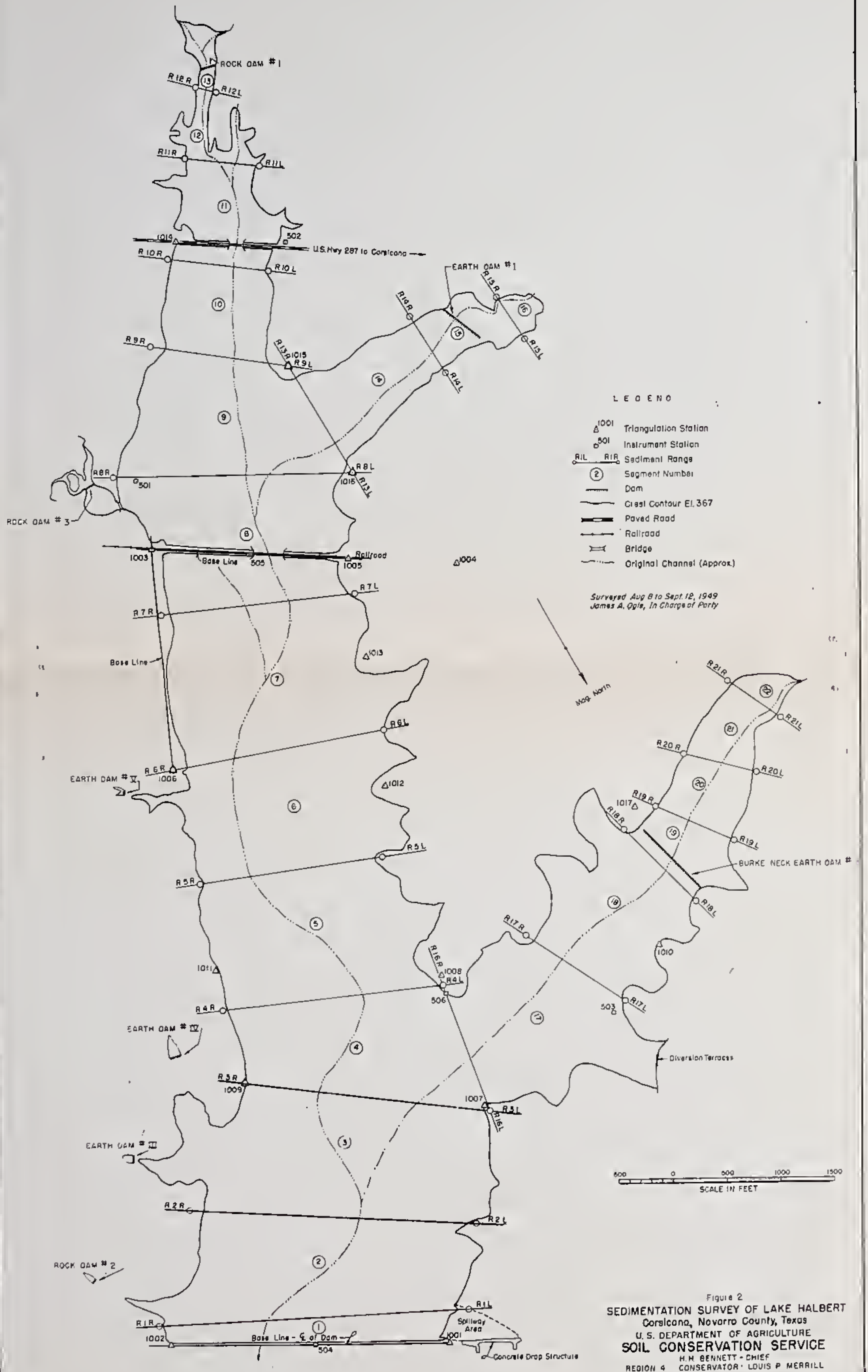

Figure 2

SEDIMENTATION SURVEY OF LAKE HALBERT
Corsicana, Navarro County, Texas
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water. Water flowing from the siphons does not enter the Lake Halbert system, but joins Elm Creek a short distance below the main dam. Magnolia Lake was built in 1884 to supplant Burke Neck as the water supply for Corsicana, and was used for that purpose until Lake Halbert was constructed in 1921. Since that date Magnolia Lake has served as a recreation center. The original capacity of the reservoir was 756 acre-feet, as determined by this survey, its surface area at crest elevation was 103.6 acres, and its drainage area, excluding the reservoir, is 0.43 square mile (see Map of Magnolia Lake, Fig. 3).

Upper and Lower Beaton Lakes receive runoff from a combined area of 0.82 square mile in the western part of the Lake Halbert drainage area. The dam of Lower Beaton Lake is located 0.75 mile west from Earth Dam No. 1 at the head of the southwest arm of Lake Halbert. Records on history and use of the two Beaton Lakes are poor, but sufficient data on age and rates of sediment accumulation to use in conjunction with the Lake Halbert measurements are available. The two Beaton Lakes were built within one or two years of 1895 for water supply for the Southern Pacific Railroad. The upper lake had suffered approximately 25 percent loss of capacity when the dam was breached at a date near 1921 and the sediment is now well compacted. During the life of Lake Halbert no water has been impounded in the upper lake, hence deposition in its basin since 1921 has been negligible.

Lower Beaton Lake had an original surface area at spillway level of 55.6 acres and a storage capacity of 319 acre-feet. Until about 1943 it was used for railroad water supply for which the draft at times reached a maximum of 100,000 gallons per day. The dam still impounds water but the lake is now used only to a limited extent for recreation

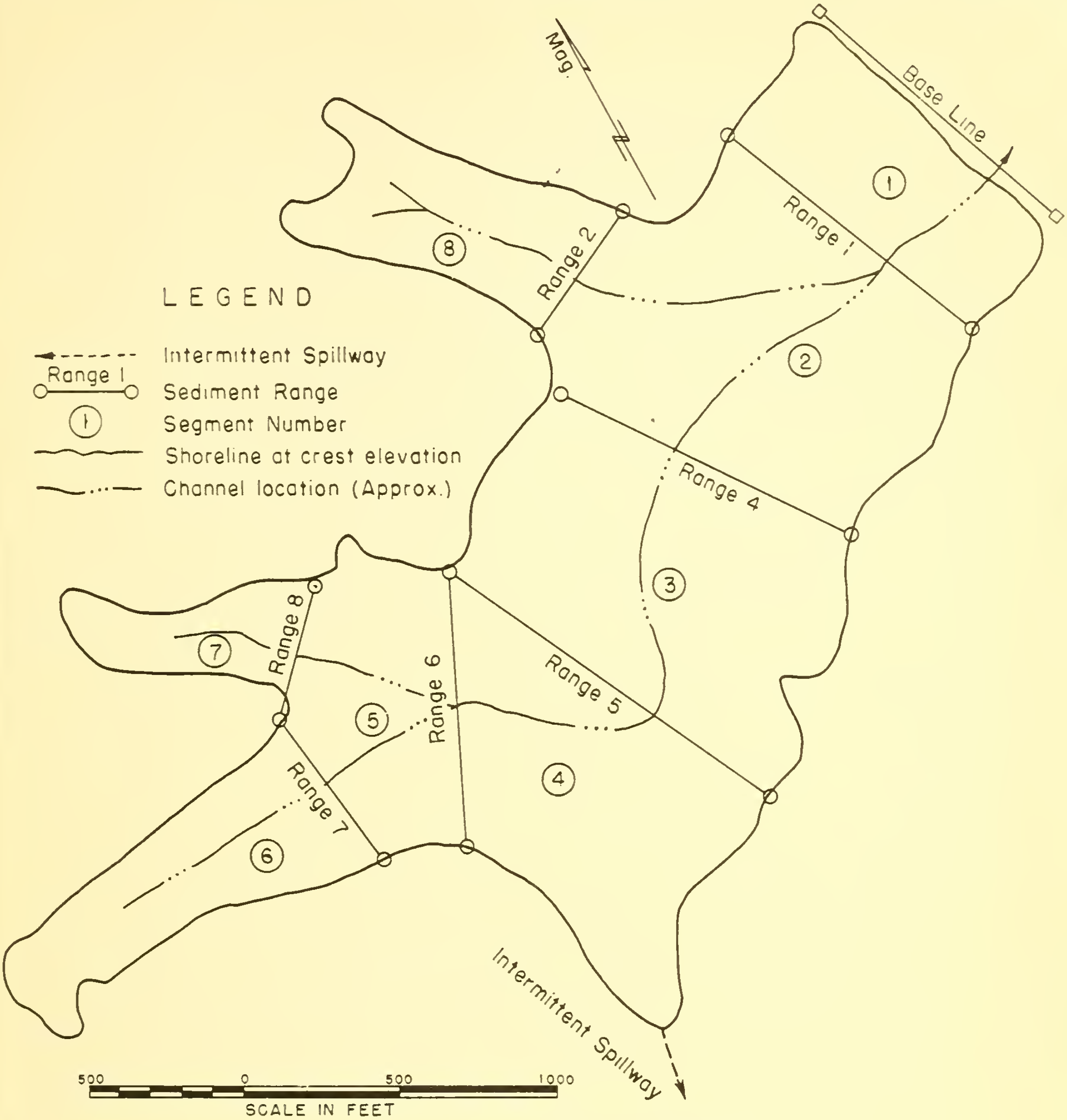

Fig. 3
SEDIMENTATION SURVEY
OF MAGNOLIA (RED HORSE) LAKE

LAKE HALBERT SEDIMENTATION SURVEY
Corsicana, Navarro County, Texas
U. S. DEPARTMENT OF AGRICULTURE
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(see Map of Lower Beaton Lake, Fig. 4).

The Lake Halbert Drainage Area

The Lake Halbert drainage area contains 10 square miles as measured by planimeter on aerial photographs. It has an extreme length of 6 miles and a maximum width, where traversed by U. S. Highway 287, of slightly more than 3 miles (see Map, Fig. 5). At the western divide the maximum elevation is about 490 feet above sea level which is 163 feet above the bottom of Elm Creek channel at the dam. The main direction of stream flow at the headwaters is easterly changing to approximately northeast near the lake. The average annual rainfall, as recorded by the U. S. Weather Bureau gage at Corsicana, is 36.2 inches.

The entire drainage area lies within the Black Prairie belt of the West Gulf Coastal Plain province. Practically all of the land has relatively low slopes ranging from 3 to 5 percent and the drainage system is well developed and dendritic. The area lies entirely within the outcrop belt of the Kemp clay and Corsicana marl formations of the Navarro group of Upper Cretaceous age. The relatively steep slopes along the eastern edge of the area are due to the outcrop of some relatively resistant marl beds.

The chief soils of the area are dark clays and clay loams of the Wilson, Crockett, Houston and Sumter types. In the small flood plains the Catalpa clay and clay-loam predominate. All of the soils are fine-textured and relatively impervious to infiltration thus promoting rapid runoff.

Erosion rates, which were in a seriously accelerated condition in 1940 to 1942, when the first reconnaissance surveys were made, have

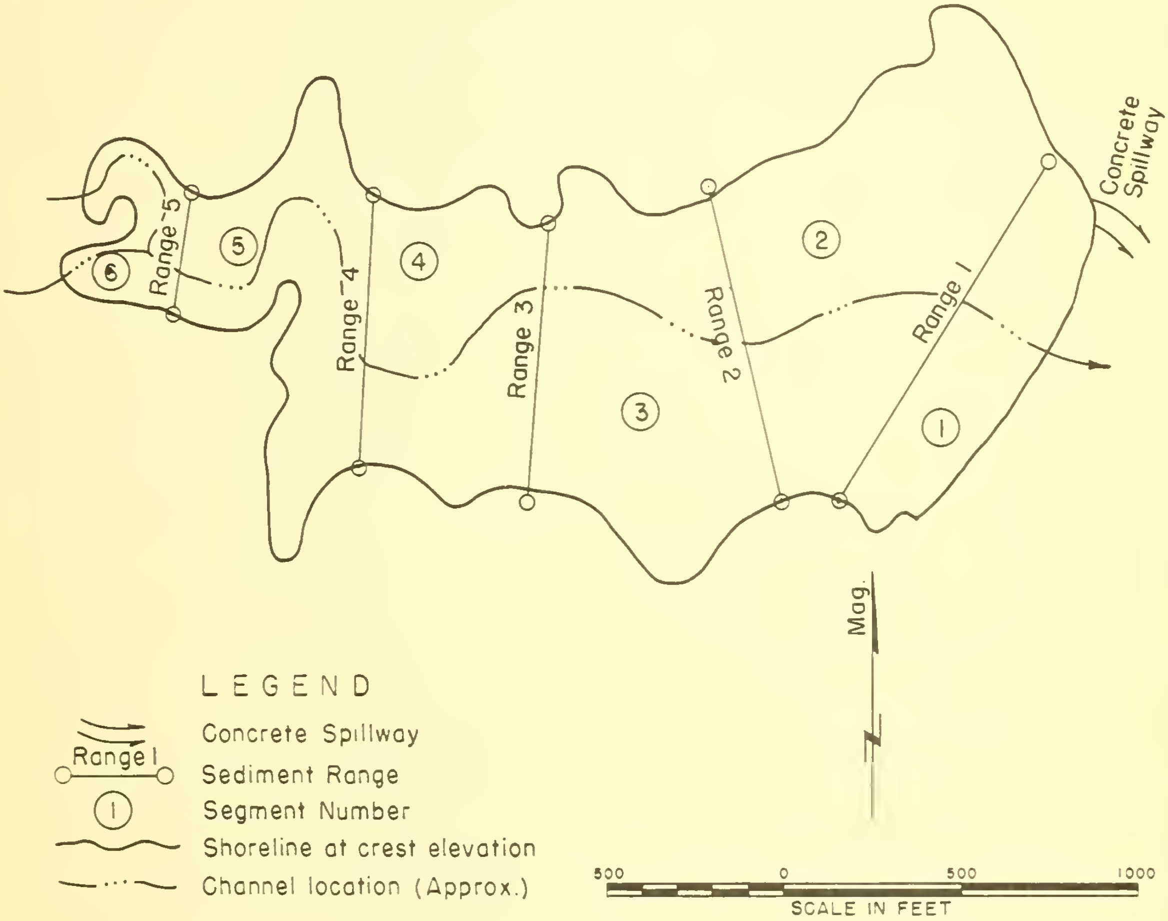

Fig. 4

SEDIMENTATION SURVEY OF BEATON LAKE

LAKE HALBERT SEDIMENTATION SURVEY
Corsicana, Navarro County, Texas
U. S. DEPARTMENT OF AGRICULTURE
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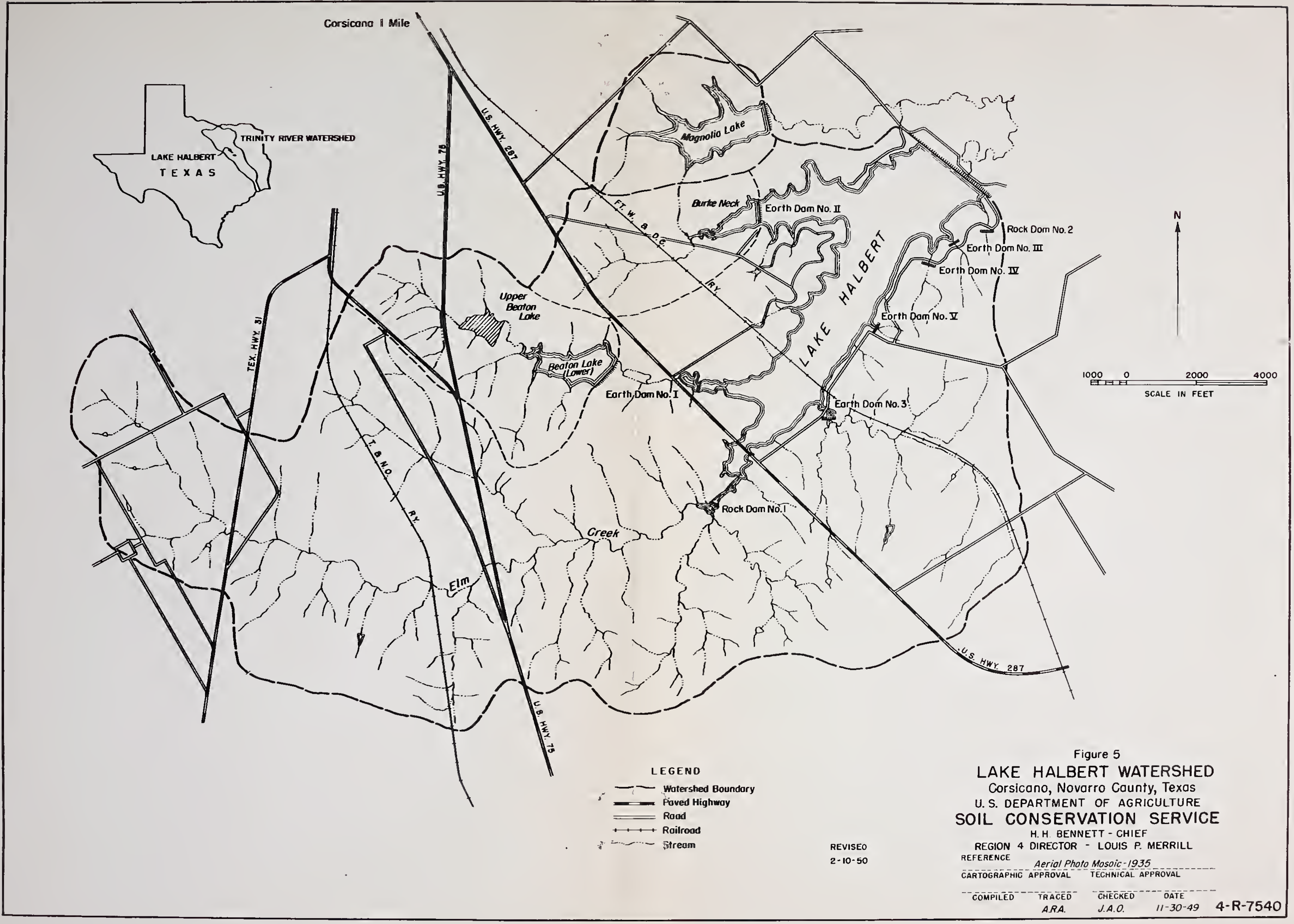

Figure 5
LAKE HALBERT WATERSHED
Corsicana, Navarro County, Texas
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been somewhat reduced by improvements in land use and methods of farm management during the past 7 years. The chief crops are cotton, corn, and grain sorghums with smaller amounts of small grains. An area of about 350 acres bordering Lake Halbert is maintained as a park by the city, and this area is included as pasture in the land use table.

Table 1, which appears below, shows that major changes in land use have occurred in the 7 years since 1942.

Table 1. Land Use in the Lake Halbert Drainage Area
(Lake Areas Excluded)

	1942	1949
	Percent	Percent
Land Use Type		
Cultivated	75	31
Retired from cultivation	0	26
Pasture	23	41
Woodland Pasture	2	2
Totals	100	100

Land in cultivation has been reduced from 75 percent of the drainage area to 31 percent. Most of the land shown as retired from cultivation is idle or is used for limited pasture. Erosion in the Lake Halbert area is chiefly of rill and sheet types. Small gullies are relatively numerous, but most of them have not exceeded 5 feet in depth or 400 feet in length. Many of the gullies have been partly or wholly stabilized by grass cover since 1942.

Sedimentation in Lake Halbert and Tributary Basins

Survey Methods

The survey of Lake Halbert and its upstream basins was made during the period August 8 to September 12, 1949. James A. Ogle, party chief, was assisted by R. L. Thigpin, Flood Control Engineer, and a 4-man engineering survey party of the Soil Conservation Service Office at Corsicana, and 3 city employees including the Superintendent of the Lake.

Detailed surveys of sedimentation were made on Lake Halbert, Burke Neck, Magnolia Lake and Lower Beaton Lake according to standard methods of the Soil Conservation Service. 5/ Certain variations from the standard technique are described below. A map of the shore line or spillway contour of Lake Halbert on a scale of 500 feet to one inch was prepared by a coordination of ground control with existing aerial photographs (see Map, Fig. 2). For horizontal control 3 base lines were chained: one 2574.4 feet long on the dam, one 2816.4 feet long on the railroad fill across the upper part of the lake, and one 2027.4 feet long along the east side of the lake extending downstream from the railroad track (see Map Fig. 2).

From the base lines 17 triangulation stations and 42 range ends were established. Parts of the shore line of Lake Halbert and Burke Neck were then mapped from these controls and all data located accurately on the aerial photograph. The remainder of the shore line was then transferred from the photograph to the plane table sheet by tracing the projection to scale. All survey points around the lake were marked permanently by copper plates set in concrete.

5/ Eakin, H. M., and Brown, C. B., Silting of Reservoirs (revised,) U. S. Dept. Agric. Tech. Bull. 524, 1939, pp 153-168.

Water depths were measured with a 5-pound, conical, aluminum sounding weight and marked, copper-cored line and sediment thicknesses were measured with the spud according to methods described by Eakin and Brown.5/ Sediment measurements on each range were taken at sediment edge, water's edge, and at 100-foot intervals in conjunction with soundings which were taken at 50-foot intervals. On most ranges the measurements were more closely spaced at the channel.

Cross-sections showing both original and present lake bottom were plotted on a scale of 5 feet to one inch vertically and 100 feet to one inch horizontally for all ranges in Lake Halbert and Burke Neck, and 10 feet to one inch vertically and 100 feet to one inch horizontally for Magnolia and Lower Beaton Lakes. The cross-section areas below spillway level and areas of segments between ranges were determined by planimeter measurement. Then volumes of water and sediment in the reservoirs were calculated by segments according to the modified prismoidal formula described by Eakin and Brown. 5/

$$V = \frac{A'}{3} \frac{(E_1 + E_2)}{(W_1 + W_2)} + \frac{A}{3} \frac{(E_1 + E_2)}{(W_1 + W_2)} + \frac{h_3 E_3 + h_4 E_4 \ldots.}{130,680}$$

Where -

V = Original capacity or sediment volume in acre-feet

A'= The quadrilateral area, or the area in acres of the quadrilateral formed by erecting a perpendicular from the downstream bounding range of the segment to the intersection of the lake shore line with the upstream bounding range (or most nearly parallel range in case the segment is bounded by more than two ranges) on one side of the lake, and erecting another perpendicular from the upstream range to the shore line on the opposite side of the lake at its intersection with the downstream range.

A = Area of the segment in acres.

E = The cross-section area in square feet of sediment and water or sediment as cut by the bounding range.

W = Width (length of bounding range) at crest elevation in feet.

h = The perpendicular distance from the range on a tributary to the junction of the tributary with the main stream, or if this junction is outside the segment, to the point where the thalweg of the tributary intersects the downstream range.

For the segment adjacent to the dam, Segment 1, the following formula was used:

$$V = A\frac{E}{W} - V_o \quad \left(V_o = \frac{HBL}{174{,}240}\right)$$

Where -

A = Surface area in acres.

E = Square feet of original area of cross-section and sediment area.

V_o = Volume of submerged part of dam.

H = Height of dam to spillway crest.

B = Width of base of dam, center to upstream edge.

L = Length of dam.

Less detailed methods were used for measuring sediment in the small check dam pools adjacent to Lake Halbert. Detailed shore line maps were not prepared, but sufficient measurements of length and width were made by stadia to establish reasonably accurate figures on surface areas of the pools. Locations of soundings and sediment measurements on ranges were determined by stadia. Volumes of water and sediment were calculated by an average depth method.

Character and Distribution of Sediment

The sediment in all of the reservoirs and impounding basins is predominantly clay with various proportions of silt and fine sand (see Fig. 6,* Typical Graphs of Sediment Samples, and Table 2). The higher proportions of fine and very fine sand, ranging upward to 33 percent, and a few calcareous pebbles, occur chiefly in the heads of some bays tributary to the east side of Lake Halbert, and in similar situations in Magnolia and Lower Beaton lakes. The prevailing color of the sediment is medium to dark gray. Some of the sediment has been compacted by exposure to atmosphere during 3 periods of low water, one of which occurred during the summer of 1949 when the water level subsided to 6 and 7 feet below spillway crest level for some weeks. The dry weight per cubic foot of 7 samples of the bottom sediment ranged from 28 to 116 pounds, and the average for the entire deposit in Lake Halbert was calculated to be 67.4 pounds per cubic foot.

The larger concentrations of sediment occur above the Highway 287 crossing and above Rock Dam No. 1 at the head of Lake Halbert, in Burke Neck, and in similar locations at the heads of Beaton and Magnolia Lakes. Substantial thicknesses of sediment occur, however, on almost the entire submerged areas of all the basins.

On range 1 (see Reservoir Map, Fig. 2) near the dam the maximum sediment thickness in Lake Halbert, (13.5 feet) occurs in the submerged borrow pit. On the adjacent submerged valley flat the common sediment thickness ranges from 1.0 to 2.0 feet. In the main lower part of the reservoir, Segments 3, 4, 5 and 6, and 7, the submerged channel, ranging from 4 to 8 feet in original depth, is almost completely filled with sediment. On the adjacent flat areas the average thickness is about 1.0

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* American Geophysical Union Classification.

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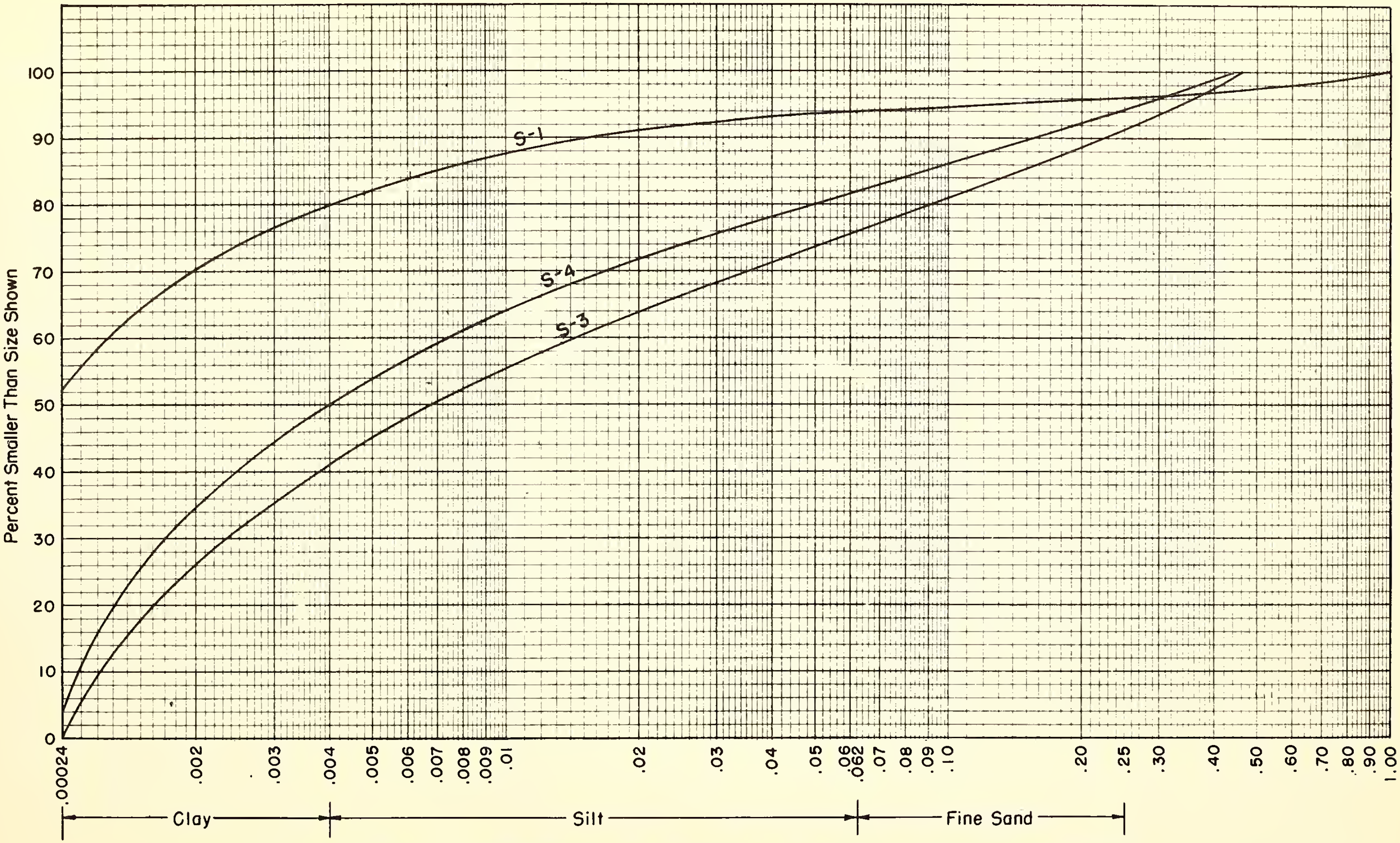

Figure 6. Cumulative Curves Showing Textures of Typical Sediment Samples From Lake Halbert Corsicana, Navarro County, Texas.

C.M.D. 2-9-50 4-L-7601

foot. Segments 8, 9, and 10 between the railroad bridge and Highway 287, have lost 50 percent to 75 percent of their original capacity and sediment thicknesses range from 3 to 13 feet in most of the area. Segments 11 and 12, above Highway 287, have an average thickness near 10 feet of sediment, and have suffered 70 to 80 percent loss of original capacity. Segment 14, in the southwest arm of the lake has lost approximately 50 percent of its original capacity despite the protection of the check dam at its head. Segments 17 and 18 in the large northwestern arm have an average sediment thickness of only about 1.0 foot because of protection by the dam upstream (Burke Neck).

In the basin of Burke Neck, which is impounded by the oldest dam in the system, the thickness of sediment ranges from 3 to 7 feet on the greater part of the bottom beneath original water depths of 4 to 12 feet. The 5 small basins along the east shore of Lake Halbert have sediment deposits ranging from 1.3 to 4.3 feet in average thickness.

Magnolia Lake has maximum thicknesses of near 8.0 and 6.0 feet of sediment respectively in segments 1 and 2 near the dam, with about 1.0 foot away from the channel. Farther upstream in the basin average thicknesses of about 0.8 to 1.2 feet were measured. No substantial accumulations of sediment were found at the heads of the 3 main bays. Lower Beaton Lake has a relatively thick sediment deposit from the dam to its upstream end. Maximum thicknesses in all segments range from 6 to 7 feet, and average thicknesses on flats away from the channel range from 2 to 4 feet.

Table 2

Texture of Sediment Samples from Lake Halbert, Navarro County, Texas.

Sample Number	Sand (Percent)	Silt (Percent)	Clay (Percent)
S - 1	6	14	80
S - 2	6	11	83
S - 3	24	35	41
S - 4	18	31	51
S - 5	33	22	45
S - 6	11	19	70
S - 7	19	23	58
S - 8	9	21	70
S - 9	11	19	70
S - 10 1/	29	33	38

1/ Top soil from cultivated area near lake.

Capacity Loss and Drainage Area Relationships

It is evident from Table 3 that accurate interpretations of drainage area relationships to all of the reservoirs and smaller basins in the Lake Halbert system are difficult. Certain conclusions of value, both to the water supply problem and to the conservation and flood control programs, however, are apparent.

Effects of the small Check Dams

The survey has shown that the amount of sediment trapped by the small check dams built in 1936 is negligible. Seven dams, including Rock Dams No. 1, 2, and 3, and Earth Dams No. I, III, IV, and V (see Table 3 and Map, Fig. 2), have caused deposition of an aggregate total volume of only 32.4 acre-feet of sediment in their basins in a 13-year period. This is approximately 5 percent of the volume of deposits accumulated in Lake Halbert during the same period. Furthermore, the basins behind all 7 of the dams mentioned above are now so nearly filled with sediment that the larger part of the sediment in future runoff will be carried past the dams. All of the basins in this group have low trap efficiency chiefly because of very low capacity to drainage area ratios, ranging from 0.1 to 23.2 acre-feet per square mile. Therefore, the figures in Table 3 on rates of sediment contribution from their drainage areas are much too low to indicate actual sediment output.

Relationships of the Larger Subsidiary Reservoirs

Burke Neck, also known as Earth Dam No. II, has impounded water and sediment continuously for a 69-year period beginning in 1880 (see Table 4). Its original ratio of capacity to drainage area of 335 acre-feet per square mile is relatively high and indicates that a high

Table 3

Summary of Sedimentation and Drainage Area Relationships
Lake Halbert Reservoir System, Corsicana, Texas.

Reservoir 1/	Date Built 2/	Drainage Area	Original Capacity	Annual Capacity Loss	Annual Volume Sediment	Annual Sed. Contribution per Sq.Mi.of Drainage Area	Original Capacity per Sq.Mi. Drainage Area	Remarks
		Sq. Mi.	Ac.-Ft.	Percent	Ac.-Ft.	Ac.-Ft.	Ac.- Ft.	
Rock Dam No. 1	1936	5.37	9.69	5.0	0.53	0.10	1.80	Most sediment bypasses this dam
Rock Dam No. 2	1936	0.02	0.32	3.0	0.01	0.50	16.0	Sediment storage effect is negligible
Rock Dam No. 3	1936	1.52	4.96	8.0	0.38	0.25	3.26	Not impounding additional sediment
Earth Dam No.1	1936	1.13	26.24	5.0	1.40	1.24	23.22	73% of drainage controlled by Beaton Lakes
Earth Dam No.II (Burke Neck)	1880	0.54	181	0.71	1.29	2.39	335.2	Receives very little water and sediment from Magnolia Lake
Earth Dam No.III	1936	0.12	0.63	5.0	0.03	0.25	5.25	No longer effective as silt trap
Earth Dam No.IV	1936	0.10	1.40	4.0	0.06	0.60	14.0	Ineffective as silt trap
Earth Dam No. V	1936	0.02	0.26	3.0	0.08	0.04	13.0	Not impounding additional sediment
Magnolia Lake	1884	0.43	659.0	0.23	1.52	3.53	1533.0	No cultivation in this drainage area.
Upper Beaton Lake	1895	0.44	76.0	2.0	1.77	4.02	172.0	Received sediment from 1895 to 1921
Lower Beaton Lake	1895	0.82	319.0	0.66	2.11	2.57	389.0	Now receives sediment from entire Beaton Lakes Drainage area.
Lake Halbert	1921	10.00	8.012	0.60	48.39	5.~~11~~ 66	801.2	Spillway raised 1.0 foot in Jan. 1950.

1/ For locations of the reservoirs see maps (Figs. 5). 2/ Date of this survey August 1949.

Table 4
Summary of Sedimentation Data on Burke Neck Lake
Corsicana, Texas.

	Quantity	Unit
Excluding Magnolia Drainage Area		
Age 1/	69	Years
Drainage Area, Excluding Lake	343 0.54	Acres Sq. Mi.
Reservoir Area & Capacity		
Area, Original & Present	29	Acres
Storage Capacity at Crest Elevation		
Original	181	Ac.Ft.
Present	92	Ac.Ft.
Capacity Per Sq. Mi. of Drainage Area		
Original	335.19	Ac.Ft.
Present	170.37	Ac.Ft.
Sedimentation		
Total Sediment	89	Ac.Ft.
Average Annual Sediment Accumulation	1.29	Ac.Ft.
Per Sq. Mi. of Drainage Area	2.39	Ac.Ft.
Per Acre of Drainage Area	163.83	Cu.Ft.
Depletion of Storage Capacity		
Per Year	0.71	Percent
To date of Investigation	49.17	Percent

1/ Dam was built about 1880. Date of this investigation, September, 1949.

Table 5

Summary of Sedimentation Data on Magnolia Lake

Corsicana, Texas.

	Quantity	Unit
Age [1]	64	Years
Drainage Area, Excluding Lake	278	Acres
	0.43	Sq. Mi.
Reservoir Capacity & Area		
Area, Original and Present	103.6	Acres
Storage Capacity at Crest Elevation		
Original	756	Ac.Ft.
Present	659	Ac.Ft.
Capacity per Sq.Mi. of Drainage Area		
Original	1758.1	Ac.Ft.
Present	1532.6	Ac.Ft.
Sedimentation		
Total Sediment	97	Ac. Ft.
Average Annual Sediment Accumulation	1.52	Ac. Ft.
Per Sq. Mi. of Drainage Area	3.53	Ac. Ft.
Per Acre of Drainage Area	238.17	Cu. Ft.
Depletion of Storage Capacity		
Per Year	0.20	Percent
To Date of Investigation	12.83	Percent

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[1] Dam was built about 1885. Date of this investigation, September, 1949.

Table 6

Summary of Sedimentation Data on Lower Beaton Lake

Corsicana, Texas.

	Quantity	Unit
Age 1/	54	Years
Drainage Area, Excluding Lake	525	Acres
	0.82	Sq.Mi.
Reservoir Area & Capacity		
Area Original and Present	55.6	Acres
Storage Capacity at Crest Elevation		
Original	319	Ac.Ft.
Present	205	Ac.Ft.
Capacity per Sq.Mi. of Drainage Area		
Original	389.02	Ac.Ft.
Present	250.00	Ac.Ft.
Sedimentation		
Total Sediment	114	Ac.Ft.
Average Annual Sediment Accumulation	2.11	Ac.Ft.
Per Sq. Mi. of Drainage Area	2.57	Ac.Ft.
Per Acre of Drainage Area	175.07	Cu.Ft.
Depletion of Storage		
Per Year	0.66	Percent
To Date of Investigation	35.74	Percent

1/ Lake was built about 1895. Date of this investigation, September, 1949.

Table 7

Summary of Sedimentation Data on Lake Halbert

	Quantity	Unit
Age 1/	28	Years
Drainage Area 2/	6068	Acres
	9.48	Sq.Mi.
Reservoir		
Area at spillway elevation 3/	593	Acres
Storage Capacity: 3/		
Original	8012	Ac.Ft.
At date of survey	6657	Ac.Ft.
Capacity per sq. mi. of drainage 2/3/		
Original	845.15	Ac.Ft.
At date of survey	702.22	Ac.Ft.
Sedimentation		
Total sediment 4/	1355	Ac.Ft.
Average annual sediment accumulation	48.4	Ac.Ft.
Per Square Mile of drainage 5/	5.66	Ac.Ft.
Per Acre of drainage 5/		
By volume	385.1	Cu.Ft.
By weight 6/	12.98	Tons
Depletion of Storage		
Loss of original capacity per year 3/ 4/	0.60	Percent
Loss of original capacity to date of survey 3/ 4/	16.91	Percent

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1/ Dam was built in 1921. Date of this survey, August-September 1949

2/ Including area of lake. Excluding area above Beaton, Burke Neck and Magnolia dams.

3/ Does not include area and capacity (original and present) behind Burke Neck Dam, segments 19B, 20, 21 and 22 on reservoir map.

4/ Excluding sediment behind Burke Neck Dam.

5/ Excluding area of Lake Halbert, 0.93 square miles.

6/ Using weighted average dry weight of 67.4 pounds per cubic ft. of sediment as determined from 7 samples.

proportion of the sediment delivered to the reservoir was deposited in it. Only vague indications of land use in the drainage area during the first 40 years of the life of Burke Neck are available, but it is known that 50 to 60 percent of the area has been cultivated without specific erosion control during the past 20 years. Neither sheet erosion nor gully development is as serious in this drainage area as in much of the main watershed of Lake Halbert, and the indicated rate of sediment output of 2.39 acre-feet per square mile annually (see Table 4) is believed to be a good indication of the true rate.

The original capacity of Burke Neck, 181 acre-feet, has been depleted nearly 50 percent in 69 years at an average rate of 1.29 acre-feet annually. Therefore, during the 13-year period from 1936 to 1949 it impounded some 17 acre-feet of sediment, which is one-half as much as the total accumulation in 7 small check basins during a like period. It is believed that the overflow from Magnolia Lake through the excavated channel has had a negligible effect upon sedimentation in Burke Neck, since the channel rarely carries any water.

Magnolia Lake, built about 1885, is the second oldest lake in the Lake Halbert system. Its drainage area of 0.43 square mile is not within the Lake Halbert watershed. Investigation of the bypass channel mentioned in the preceding paragraph showed that only insignificant amounts of sediment have been transported through it from Magnolia Lake. Furthermore, the lake has no true spillway, and the water level is maintained at a stage about 2 feet below the top of the dam by intermittent use of 2 siphons passing over the dam. These factors plus the very high original capacity to drainage area ratio of 1758 acre-feet per square mile indicate a trap efficiency approaching 100 percent.

Therefore, it seems probable that nearly all of the sediment eroded from the drainage area has been deposited in the lake basin.

Table 5 shows that the total loss of storage capacity in Magnolia Lake has been only 12.8 percent in 64 years, but that the average annual contribution of sediment from the drainage area has been 3.53 acre-feet. Various local records are in good agreement that no part of the drainage area has been cultivated. It is classified as pasture, but mesquite trees are numerous and the grass cover is thin and poor. Consequently the rate of sediment contribution from the drainage area of Magnolia Lake is regarded as a good indication of erosion rates on very poor pasture in this part of the Black Prairie.

Only general interpretations of drainage area relationships above the two Beaton Lakes can be made because of some uncertainty as to their exact age and the broken dam at Upper Beaton Lake. Table 6 shows that Lower Beaton Lake has lost 36 percent of its original capacity in 54 years since construction of the dam. Although the ratio of original storage capacity to drainage area of 389 acre-feet is moderately high, numerous turbid flows have passed the dam following rains. The average annual contribution of sediment from the drainage area to Lower Beaton Lake alone has been 2.57 acre-feet per square mile annually, but this figure does not include the deposit in Upper Beaton Lake.

In a 36-year period from 1885 to 1921 Upper Beaton Lake received a total volume of approximately 64 acre-feet from a 0.44 square mile drainage area. The annual average volume of sediment which was about 1.8 acre-feet, represents an average annual contribution of 4.0 acre-feet per square mile of drainage. Hence the average annual contribution of sediment to both Beaton Lakes from the entire drainage area has been in the range of about 3.0 to 3.5 acre-feet per square mile. This rate has occurred in a drainage area which has been approximately 50 percent cultivated much of the time. The pasture, however, has better cover than that of Magnolia Lake and slopes are more gentle. Much of the Lake Halbert drainage area has higher erosion rates than those of the Lake Beaton watershed.

One conspicuous feature of the Lake Halbert drainage area as a whole is the high average rate of sediment contribution. Table 7 shows that the average rate of sediment contribution during the 28-year period since construction of the dam has been 5.7 acre-feet annually per square mile. The average annual rate of capacity loss of 0.6 percent would be much higher if the reservoir did not have such a favorable original ratio of storage capacity to drainage area (845 acre-feet per square mile). A calculation of total deposition in all of the reservoirs and small basins in the system, excluding Magnolia Lake, for the 13-year period from 1935 to 1949 showed that an average annual total deposit of about 55.5 acre-feet was contributed from the 10-square mile drainage area. This is equivalent to an average rate of 5.5 acre-feet per square mile annually from the area as a whole.

The high rates of erosion have caused serious reduction in soil fertility and increases in costs of cultivation. These damages are reflected in Table 1 which shows a reduction of more than 50 percent in cultivated land area since 1942. Studies of the drainage area indicate that sheet erosion is the principal process of erosion, but that many small rills and small shallow gullies also have removed much soil from the valley slopes.

It is not possible to make good comparisons on sediment output rates at present with those prevalent at the time of the 1938 reconnaissance survey of Lake Halbert, largely because accurate figures on original capacity were not available. Considering the present trend in land use toward returning most of the steeply sloping lands to pasture and the current development of conservation farming, it is believed that the rate of erosion has passed its peak. Future surveys of Lake Halbert should show a substantial decline in rate of sediment output.

Summary

Water Supply

In the absence of stream flow records for Elm Creek, no detailed study of the effect of drought periods upon the operation of Lake Halbert can be made. As a result of the detailed sedimentation survey, however, some estimates of the adequacy of the reservoir for city water supply are possible. Records of the City Water Department show that 3 drought periods, combined with pumping for city use and the effect of evaporation, have reduced the level of water in Lake Halbert to about 7 feet or more below spillway crest for some weeks. Inflow from Elm Creek during these periods has practically ceased.

At a stage of 7 feet below spillway level in the fall of 1949 the volume of water in the reservoir was about 2,916 acre-feet, as calculated from data of this survey. The trend in water use since 1943, as tabulated in Table 8, indicates that the present average daily consumption is about 1.65 million gallons per day, but that the average daily consumption during warm dry summer months would be about 3.2 million gallons per day.

Table 8

Total Water Use at Corsicana

Year	Total Water Used Gallons	Average Daily Use Gallons
1943	498,839,000	1,367,000
1944	472,626,000	1,295,000
1945	427,915,000	1,172,000
1946	472,107,000	1,293,000
1947	522,634,000	1,432,000
1948	600,782,000	1,646,000
1949	601,767,000	1,649,000

For an approximation of the effects of a prolonged drouth, it is assumed that the reservoir would be drawn down to a level 7 feet below spillway crest, as in the fall of 1949, and the drouth continued without rainfall or runoff for an additional 2-month period. This approximates the extreme drouth which might recur in this locality. Water use, at 3.2 million gallons per day, during the 2-month period would be approximately 192 million gallons or 590 acre-feet. Evaporation, at an estimated rate of 5 inches per month on an average area of about 300 acres, would remove an additional 264 acre-feet of water from the reservoir. Then, at the end of the drouth period, about 2,062 acre-feet of water would remain in the reservoir. At the present rate of use, not including evaporation, this represents about 10 months' supply.

Therefore, at the present rate of water use, Lake Halbert should furnish adequate water for the City for 20 to 25 years hence. This assumes, however, that no new industries would enter the City and that the population would remain static. Records of the Chamber of Commerce show that a dairy products processing plant requiring 800,000 gallons of water per day and a glass manufacturing plant have been unable to locate in Corsicana because of the limited water supply. A request concerning facilities available for a chemical plant is now pending. Hence it seems urgent that the City of Corsicana make provision for immediate additions to its water supply. New industrial developments and substantial City growth require additional water, or the City will gradually approach a static condition.

Capacity Loss and Erosion Rates

The survey of the Lake Halbert reservoir system has shown that high rates of sediment output, ranging from 2.4 to 5.5 acre-feet per square mile annually have resulted from intensive cultivation of clean-tilled crops without any regard to control of erosion. Only the large original capacity-drainage area ratio of Lake Halbert and the larger of the subsidiary dams above it have prevented the annual rate of capacity loss from exceeding its average figure of 0.6 percent. Since 1942 the great improvement in land use and conservation farming in the drainage area have begun stabilization of most of the badly eroded areas. Future rates of deposition in the reservoirs should be substantially less than the average rates to date if the present trend in farming practices is maintained.

The 7 small desilting basins built in 1935-36 have had only negligible effect on sedimentation in Lake Halbert. They controlled about 80 percent of the drainage area but had such small capacities and low trap efficiencies that most of the sediment bypassed these dams. In the 13-year period between 1936 and the 1949 survey they impounded a total volume of only 32.4 acre-feet of sediment compared to 629 acre-feet which accumulated in Lake Halbert during the same period. The larger subsidiary basins, including Magnolia Lake, Burke Neck, and the Beaton Lakes received a combined total deposit of 70 acre-feet during the period.

Recommendations

It seems desirable to preserve the remaining utility of Lake Halbert and its auxiliary reservoirs as long as possible, as well as to develop new supplies. As a result of this survey it is estimated that rates of sediment output should be reduced by 50 percent within the next 10 years by the present conservation program in the drainage area. Therefore, it is within the best interest of the city to cooperate with the Navarro-Hill Soil Conservation District in any way that may be feasible to improve the drainage area of Lake Halbert.

No detailed study of other water sources was made during this survey, but it was known that Chambers Creek, at a point 3 to 4 miles northeasterly from the City would be a substantial source of additional water supply. Since the completion of the lake survey a survey of other water sources near the City has been made by Homer A. Hunter, Consulting Engineer of Dallas. As a result of this study, a 12-inch pipeline and pump have been constructed from a point on Chambers Creek to the Lake Halbert filter plant. This development is temporary, but adds from 1 to 2 million gallons per day to the water supply of the City. In addition the City has asked for 40,000 acre-feet of water allotment from a proposed dam under planning by the U. S. Corps of Engineers to be located about 10 miles upstream on Chambers Creek.